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RESEARCH ENERGY INDICES OF EGGPLANT PRODUCTION IN NORTH OF IRAN

Maral Moraditochaee
Department of Agriculture, Lahijan Branch, Islamic Azad University, Lahijan, Iran
E-Mail: maral_moraditochaee@yahoo.com

ABSTRACT

Optimum use of energy is very vital for agricultural productions section. This method in an agricultural product system is the energy consuming in product operations and energy saving in produced crops. In this article, evaluation of energy indices under rain fed farming eggplant in north of Iran (Guilan province) was investigated. Data were collected from 72 farms by using a face to face questionnaire method during 2011 year in Guilan province. By using of consumed data as inputs and total production as output, and their concern equivalent energy, and energy indices were calculated. The average yield of eggplant was found to be 21000 kg/ha and its energy equivalent was calculated to be 123900 MJ/ha. Energy efficiency (energy output to input energy ratio) for fruit in this study was calculated to be 9.3, showing the affective use of energy in the agro ecosystems eggplant production. Nonrenewable energy was 94.52% of total input energy that concluded that eggplant production needs to improve the efficiency of energy consumption in production and to employ renewable energy.

Keywords: energy indices, eggplant production, yield, Iran.

INTRODUCTION

Eggplant (*Solanum melongena* L.), also known as Aubergine, Brinjal or Guinea squash is one of the non-tuberous species of the night shade family Solanaceae (Kantharajah and Golegaonkar, 2004). The varieties of *Solanum melongena* L. show a wide range of fruit shapes and colors, ranging from oval or egg-shaped to long club-shaped; and from white, yellow, green through degrees of purple pigmentation to almost black. It is an economically important crop in Asia, Africa and the sub-tropics (India, Central America) and it is also cultivated in some warm temperate regions of the Mediterranean and South America (Sihachkr *et al*., 1993). Eggplant fruits are known for being low in calories and having a mineral composition beneficial for human health. They are also a rich source of potassium, magnesium, calcium and iron (Zenia and Halina, 2008).

Efficient use of energy is one of the principal requirements of sustainable agriculture. Energy use in agriculture has been increasing in response to increasing population, limited supply of arable lands, and a desire for higher standards of living. Continuous demand in increasing food production resulted in intensive use of energy inputs and natural resources. However, intensive use of energy causes problems threatening public health and environment. Efficient use of energy in agriculture will minimize environmental problems, prevent destruction of natural resources, and promote sustainable agriculture as an economical production system (Erdal *et al*., 2007). Economic production is a function of many factors such as human labor, capital, natural resources availability of energy and technology. Therefore, both the natural resources are rapidly decreasing and the amount of contaminants is considerably increasing. The best way to lower the environmental hazard of energy use is to increase the energy use efficiency (Esengun *et al*., 2007). Energy input-output analysis is usually used to evaluate the efficiency and environmental impacts of production systems. It is also used to compare the different production systems.

The main aim of this study was to determine energy use in eggplant production, to investigate the efficiency of energy consumption and energy indices analysis of eggplant in Guilan province of Iran.

MATERIALS AND METHODS

Data were collected from 72 farms by using a face to face questionnaire method during 2011 year in Guilan province (north of Iran). The random sampling of production agro ecosystems was done within whole population and the size of each sample was determined by using bottom Equation (Kizilaslan, 2009):

$$n= \frac{N\times s^2\times t^2}{(N-1)d^2+ s^2\times t^2}$$

In the formula, n is the required sample size, s is the standard deviation, t is the t value at 95% confidence limit (1.96), N is the number of holding in target population and d is the acceptable error.

In order to calculate input-output ratios and other energy indicators, the data were converted into output and input energy levels using equivalent energy values for each commodity and input. Energy equivalents shown in Table-1 was used for estimation (Kempen and Kraenzlein Rathke, 2008; Ozkan *et al*., 2004; Moradi and azarpour, 2011). Firstly, the amounts of inputs used in the production of eggplant were specified in order to calculate the energy equivalences in the study. Energy input includes human labor, machinery, diesel fuel, chemical fertilizers, poison fertilizers and seed and output include yield of eggplant. The energy use efficiency, energy specific, energy productivity and net energy gain were calculated according to bottom equations (Kempen and

Kraenzlein Rathke, 2008; Moradi and azarpour, 2011; Ozkan *et al*., 2004).

$$\text{Energy ratio} = \frac{\text{Output energy (Mj/ha)}}{\text{Input energy (Mj/ha)}}$$

$$\text{Energy production} = \frac{\text{Grain yield (Kg/ha}}{\text{Input energy (Mj/ha)}}$$

$$\text{Energy intensity} = \frac{\text{Input energy (Mj/ha)}}{\text{Grain yield (Kg/ha)}}$$

Net energy gain =
Output energy (Mj/ha) - Input energy (Mj/ha)

The input energy was divided into direct, indirect, renewable and non-renewable energies (Kizilaslan, 2009; Ozkan *et al*., 2004). Direct energy covered human labor and diesel fuel used in the peanut production while indirect energy consists of seed, chemical fertilizers, poison fertilizers, and machinery energy. Renewable energy consists of human labor and seed and nonrenewable energy includes chemical fertilizers, poison fertilizers and machinery energy.

RESULTS AND DISCUSSIONS

Analysis of input-output energy use in eggplant production

The inputs used in eggplant production and their energy equivalents and output energy equivalent are illustrated in Table-1. About 0.7 kg seed, 270 h human labor, 3 L poison chemical, 12 h machinery power and 110 L diesel fuel for total operations were used in agro ecosystems eggplant production on a hectare basis. The use of nitrogen fertilizer, phosphorus and potassium were 69, 21 and 20 kg per one hectare respectively. The total energy equivalent of inputs was calculated as 13316 MJ/ha.

The highest shares of this amount were reported for diesel fuel (46.81%) and chemical fertilizer (39.65%), respectively. The energy inputs of poison (2.72%), machinery (5.69%), human labor (5.48%) and seed (0.03%) were found to be quite low compared to the other inputs used in production (Figure-1).

The average fruit yield of eggplant was found to be 21000 kg/ha and its energy equivalent was calculated to be 123900 MJ/ha (Table-1).

Table-1. Amounts of inputs and output and their equivalent energy from calculated indicators of energy.

Parameter	Unit	Quantity per hectare	Energy equivalents	Total energy equivalents
Inputs				
Human labor	h/ha	370	1.96	725.20
Machinery	h/ha	12	62.7	752.40
Diesel fuel	L/ha	110	56.31	6194.10
Nitrogen	Kg/ha	69	69.5	4795.50
Phosphorus	Kg/ha	21	12.44	261.24
Potassium	Kg/ha	20	11.15	223.00
Poison	L/ha	3	120	360.00
Seed	Kg/ha	0.7	5.9	4.13
Output				
Yield	Kg/ha	21000	5.9	123900

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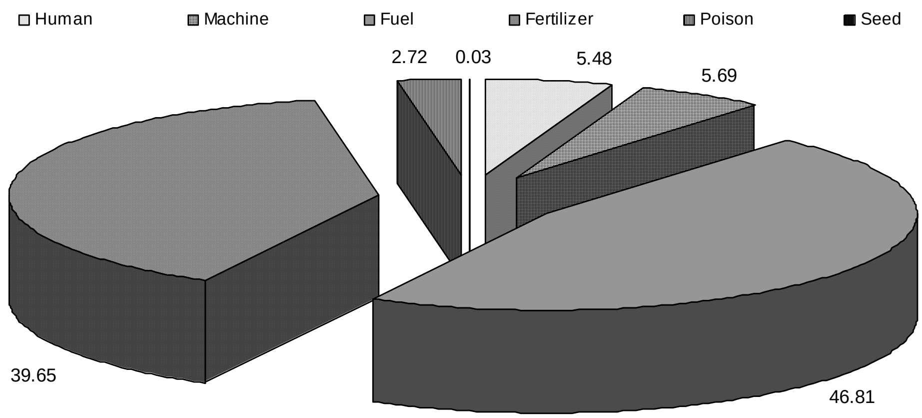

Figure-1. The share (%) production inputs in eggplant.

Evaluation indicators of energy in eggplant production

The energy use efficiency, energy production, energy specific, energy productivity, net energy gain, and intensiveness of eggplant fruit production were shown in Table-2. Energy efficiency (energy output-input ratio) in this study was calculated 9.30, showing the affective use of energy in the agro ecosystems eggplant production. Energy specific was 0.63 MJ/kg this means that 0.63 MJ is needed to obtain 1 kg of eggplant fruit. Energy productivity calculated as 1.58 Kg/MJ in the study area. This means that 1.58 kg of output obtained per unit energy. Net energy gain was 110584 MJ/ha.

This means that the amount of output energy is more than input energy and production in this situation is logical. Direct, indirect, renewable and non-renewable energy forms used in eggplant production are also investigated in Table-2. The results show that the share of direct input energy was 51.96% (6919 MJ/ha) in the total energy input compared to 48.04% (6396 MJ/ha) for the indirect energy. On the other hand, nonrenewable and renewable energy contributed to 94.52 % (12586 MJ/ha) and 5.48% (729 MJ/ha) of the total energy input, respectively.

Table-2. Analysis of energy indices in eggplant production.

Item	Unit	Eggplant
Yield	Kg/ha	21000
Input energy	Mj/ha	13316
Output energy	Mj/ha	123900
Energy use efficiency	-	9.30
Energy specific	Mj/Kg	0.63
Energy productivity	Kg/Mj	1.58
Net energy gain	Mj/ha	110584
Direct energy	Mj/ha	6919 (51.96%)
Indirect energy	Mj/ha	6396 (48.04%)
Renewable energy	Kg/Mj	729 (5.48%)
Nonrenewable energy	Mj/ha	12586 (94.52%)

CONCLUSIONS

Finally Energy use is one of the key indicators for developing more sustainable agricultural practices one of the principal requirements of sustainable agriculture, Therefore energy management in systems eggplant production should be considered an important field in terms of efficient, sustainable and economical use of energy. Using of combination machines, doing timely required repairs and services for tractors and representing a fit crop rotation are suggested to decrease energy consuming for eggplant in Guilan province.

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